

## THE IMPLICATIONS OF THE USE OF AGRICULTURAL PROTECTIVE PRODUCTIONS IN FOOD PRODUCTION ASSOCIATED WITH BIOACUMULATION IN BREAST MILK

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**Abstract:** The ingestion of food contaminated by pesticides leads to several pathologies in humans, such as the bioaccumulation of agrochemicals in breast milk, which highlights a scenario of extreme concern, given that these products have a high potential to induce genetic disorders not only in the mother, but also to the baby through breastfeeding. The objective of this bibliographical review is to highlight the toxicological action that the use of pesticides on agricultural crops provides to newborns through breastfeeding. The methodology used was based on 26 scientific articles, which were found through a search with a filter for the English language and the Boolean operator “AND”, being carried out on the digital platforms Scientific Library Online (SciELO) and PubMed, using the indexed descriptors in DeCS/MeSH: Milk human; Agrochemicals; Bioaccumulation; Poisoning. The references went through a filter selecting those that were published between 2013 and 2023. In view of the results obtained, pesticides that use organochlorines in their composition stand out, such as glyphosate, for example, which provide easy absorption through the skin. After absorption, the substances can diffuse between membranes and accumulate in organs with high levels of fat, such as breast tissue, mainly. This way, milk from lactating women promotes exposure of newborns to these toxicological substances, which can stimulate the development of cancer, leukemia, lymphoma, and brain tumors, followed by compromised immune systems. This situation becomes even more alarming due to the fact that breast milk is the only food that provides essential nutrients for child growth, causing not only the pathologies mentioned above but also a series of chronic psychomotor disorders. In conclusion, it can be inferred that the use of pesticides on crops leads to a series of permanent and neoplastic disorders in newborns, thus harming healthy

child development.

**Keywords:** Breast milk; Pesticides; Bioaccumulation

## INTRODUCTION

Physical activity, a balanced diet allows the development of a healthy life where many diseases can be avoided or, at least, have their risk drastically reduced, according to scientific evidence that demonstrates the connection between style and quality of life (physical activity, diet, smoking, obesity, stress) and the risk of premature death and chronic diseases (SOUZA et al., 2020).

The technology for applying agricultural pesticides aims to control pests, phytopathogens and invasive plants that harm the production of, among others, grains, fruits, flowers, ornamental plants and vegetables. Mastery of this technology is essential to ensure correct application, with environmental, social and human safety, as well as obtaining positive economic results. Agricultural pesticides are essential for any agricultural production system and, as they are high-risk substances, they must be used judiciously.

The increase in the world's population has become increasingly worse over the years, making its socioeconomic implications a focus of discussion. According to periodic research by the United Nations (UN), it has been revealed that the world population has been growing in an alarming and uncontrolled manner, which is estimated to reach more than 8 billion people in 2024 and, in 2050, exceeding 9.5 billion. It was concluded, therefore, that such significant growth demonstrates the requirement mainly for a greater supply of food.

The need for greater coverage in food production to meet new human needs led to the creation and use of new agricultural techniques to achieve greater crop production.

Among these advances, pesticides stand out, due to their high capacity in controlling pests and diseases; improvement of the visual quality of cultivated products; better development of plantations (greater quantity and quality); and because they are cheap and easy-to-use inputs, they have become an essential measure for the progress of agriculture.

The Pesticides Law (BRASIL, 1989) defines that these substances are the products of physical, chemical or biological processes, intended for use in the production sectors, storage and processing of agricultural products, whose purpose is to change the composition of the flora or fauna, in order to preserve them from the harmful action of living beings considered harmful. This way, pesticides are artificially produced elements, being used to combat plants and animals that have a harmful effect on agricultural practices. Therefore, pesticides are widely used in rural areas, in vegetable plantations and other plants, to combat fungi, bacteria, insects and other agents that harm the development and production of plants.

However, despite the high contribution to food production, there is a series of harm to human health related to the extensive use of pesticides on crops. Initially, poisoning by agricultural pesticides is divided into two ways, acute poisoning, which are the effects referring to a short period of time in which an individual came into direct contact with the chemical, either through contact with the skin or through absorption. oral route, and chronic intoxication, which refers to long-term effects, in which the accumulation of genetic damage occurs during repeated exposure to the toxicant over a long period of time (BRASIL, ANVISA, 2012). In most cases, the signs and symptoms of acute poisoning appear suddenly, a few minutes or a few hours after excessive exposure of an individual or a group of people to a pesticide,

in which case this case can be treated in a center. doctor with greater agility and speed, avoiding possible serious consequences. However, unlike acute intoxication, chronic intoxication, as it is characterized by long-term exposure, manifests itself through numerous pathologies, affecting various organs and systems, with emphasis on immunological, hematological, hepatic and neurological problems, malformations congenital diseases and tumors. Thus, according to studies that will be presented later in the theoretical references, we observed that agricultural pesticides can develop changes to express pathologies specifically (or together) in human cells in vitro or in the animals tested.

The high toxicological capacity of pesticides can be seen through the results of bioaccumulation in studies using, for example, cypermethrin, permethrin and glyphosate, agricultural pesticides sold in rural areas, each with a high harmful content. Furthermore, among the harmful effects, the high bioaccumulation potential of agricultural pesticides in breast milk stands out, in which intoxication can affect not only the mother, but also the baby, impacting the quality of life in general.

This bibliographic review aims to systematically analyze each toxicological action of agricultural pesticides found through the selected references, with emphasis on determining which pesticides are found in breast milk, the quantity found in the experiments and the possible damage to the health of women and babies. Furthermore, demonstrate the toxicological and bioaccumulating action of agricultural pesticides in breast milk, in addition to the quantity found and the damage to the health of women and babies, impacting quality of life.

## METHODOLOGY

The type of research related in this work is the secondary research method of a bibliographic nature. According to Gil (2006), bibliographic research is developed through theoretical references found in books, magazines, articles, and similar literature, with the aim of knowing and analyzing contributions on a given subject. This approach was chosen because it provides a foundation and in-depth information regarding the topic studied. Bibliographic research can serve as a basis for future reflections and actions, contributing to the development of thoughts and new perspectives on issues, remaining the main contribution (SILVA et al., 2015).

The present work is a bibliographical study of the integrative literature review type, with the objective of evaluating the implications of the use of agricultural pesticides in food production as a potential bioaccumulator in breast milk.

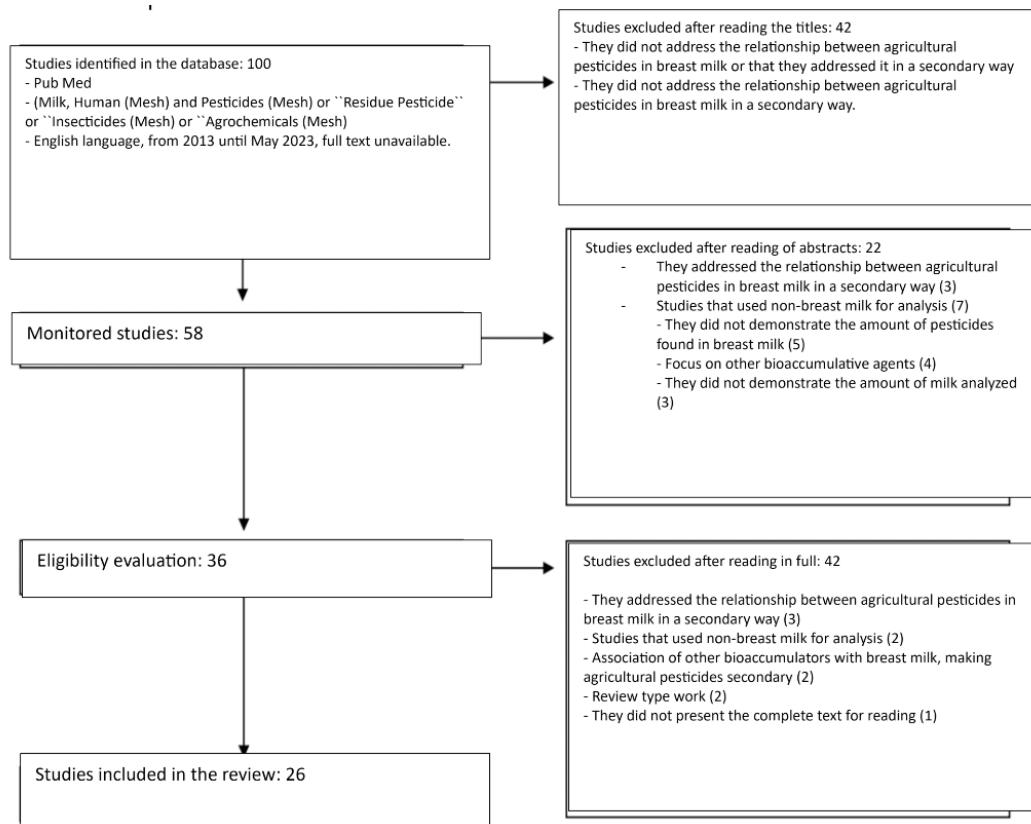
Initially, the keywords and Boolean operators for the searches were defined, and then a search was carried out in the chosen database and a record of the number of works found. To carry out this review, the following descriptors were chosen: “Milk, Human”, “Agrochemicals”, “Pesticides”, “Insecticides” and “Residue Pesticide”, selected through the controlled list of vocabulary Descriptors in Health Sciences (DeCS). In the meantime, a search was carried out in the PubMed database, using Boolean operators as follows: (“Milk, Human”[Mesh]) AND (Pesticides”[Mesh] OR “Residue Pesticide” OR “Insecticides” [Mesh] OR “Agrochemicals”[Mesh]), initially finding a total of 568 articles. The filters were defined for English-language works, with full text available and published from 2013 until May 2023, with 100 articles found.

Next, a pre-selection was made based on reading the titles, excluding those that did not address the relationship between agricultural

pesticides in breast milk or that addressed it in a secondary way, leaving 58 works. As a continuation, the summaries of the pre-selected works were read, applying the same exclusion criteria previously mentioned (they did not address the relationship between agricultural pesticides in breast milk 3), in addition to the exclusion of works that used non-breast milk for analysis. (7), did not demonstrate the quantity of pesticides found in breast milk (5), which focused on other bioaccumulating agents (4), did not demonstrate the quantity of milk analyzed (3), and 22 articles were excluded at this stage. In the meantime, a total of 36 works were selected for eligibility assessment, consisting of reading in full, and subsequently removing texts that, in addition to the aforementioned criteria (did not address the relationship between agricultural pesticides in breast milk 3): did not present the text complete for reading (1), used non-breast milk for the analysis (2), associated other bioaccumulators with breast milk, giving second place to agricultural pesticides (2), or were review-type works (2), with a total of 10 excluded work at this stage.

In short, 26 articles were approved by the aforementioned inclusion and exclusion criteria to be included in the present review. Figure 1.1 identifies the selection and exclusion flowchart of the analyzed studies, representing the criteria described in the methodology.

The results were presented in a descriptive way, divided into thematic categories covering: Historical aspects; Pesticides; Cypermethrin, permethrin and glyphosate: examples of pesticides and health impacts.



**Figure 1.1** – Flowchart showing the selection process of articles included in the review

## RESULTS AND DISCUSSION

### HISTORICAL ASPECTS

With advances in the areas of medicine, improvements in quality of life, an increase in the rate of vegetative growth (natural growth) and a decrease in infant mortality rates, there has been an alarming population growth, becoming a recurring issue to be debated in society about its current impacts. Thus, the increase in per capita consumption, per capita income and the slight expansion of cities were stimulated, highlighting the need for a broad discussion about the inability to meet new human needs.

Among the research on the “new” problem, the Malthusian Theory present in the work “Essay on the Principle of Population” stands out, in which the author concluded that, if population growth were not contained,

the population would grow according to a geometric progression, and food production would grow according to an arithmetic progression, considering that the population would double every 25 years. If the theory were confirmed and there was this mismatch between the increase in population and the lack of food, the result would be a hungry world population, living in a situation of poverty, which would cause a disruption in social life. However, this theory did not materialize, since Malthus did not predict that the Industrial Revolution would be capable of changing the entire world scenario, introducing new techniques into rural areas, which would boost agricultural production (CARVALHO et al., 2022).

According to the United Nations (UN), the world population in 2024 will be more than 8 billion people and, in 2050, more than 9.5 billion, mainly requiring a greater food supply.

This growing need means that the agricultural production process is increasingly being subjected to strong technological changes, thus aiming to increase productivity. This fact is mainly brought about by the “Green Revolution”, a process of transformation in agriculture on a global scale that occurred through the development and incorporation of new technological means in production, beginning in the second half of the 20th century, between the 1960s. and 1970. It was implemented through the incorporation of technological innovations in production and was based on the production of genetically modified seeds, agricultural machinery and chemical inputs, such as fertilizers and pesticides. In Brazil, technical incorporation was carried out through government incentives concomitantly with the expansion of agricultural frontiers to the savannah regions. The purpose of the Green Revolution was, initially, to increase food production on a global scale as a way of guaranteeing food security. Although productive gains were recorded in several countries, the Green Revolution brought with it several consequences for the environment.

In contemporary Brazil, part of agriculture is undergoing a continuous process of modernization, via the incorporation of new technologies, with the prospect of increasing competitiveness in the international market. “Agricultural modernization”, while on the one hand generates economic growth, on the other hand has potential risks to the environment and human health (DUTRA; SOUZA, 2017). Among the various risks, the expulsion of small landowners and rural workers from the countryside stands out – resulting from the increase in relative costs for production due to competition with large landowners and large companies, in addition to new techniques incorporated into the field that required greater qualifications. professional,

which ended up putting many less qualified workers in a situation of unemployment – as well as the harmful effects associated with the massive and chronic use of pesticides, which will be the focus of this work.

The Brazilian agricultural production process is increasingly dependent on pesticides and chemical fertilizers. The pesticide law (BRASIL, 1989) and the decree that regulates it (BRASIL, 2002) define that these substances are products and agents of physical, chemical or biological processes, intended for use in the production, storage and processing sectors. of agricultural products, in pastures, in the protection of forests, native or established, and other ecosystems and also of urban, water and industrial environments, the purpose of which is to alter the composition of flora or fauna, in order to preserve them from the action harm to living beings considered harmful.

The culture of using pesticides in Brazil began in the sixties, when the so-called National Development Plan (PND) adopted by the government of General Emílio Garrastazu Médici imposed on rural producers that bank financing to purchase seeds would only be granted to those who did also the purchase of fertilizer and pesticides. With this obligation, the use of pesticides increased exponentially, contributing to the near extinction of alternative and ecologically healthy pest management practices. Thus, such alarming growth was evidenced according to data from the National Health Surveillance Agency (Anvisa) and the Pesticide Industry Observatory of the “Universidade Federal do Paraná” released during the 2nd Seminar on Pesticide Market and Regulation, held in Brasília, DF, in April 2012, while in the last ten years the global pesticide market grew 93%, the Brazilian market grew 190%. In 2008, Brazil overtook the United States and became the world’s largest pesticide market (ANVISA, 2019).

Based on data from the Brazilian Agricultural Census (IBGE, 2006), Bombardi (2011) verifies the intensity of pesticide use by municipalities in Brazil, which shows that 27% of small properties (from 0 to 10 hectares), 36% of properties measuring 10 to 100 hectares and 80% of properties larger than 100 hectares use pesticides. Furthermore, it is noted that the highest concentrations of pesticide use coincide with regions with the highest intensity of monocultures of soybeans, corn, sugarcane, citrus fruits, cotton and rice. Mato Grosso is the largest consumer of pesticides, representing 18.9%, followed by São Paulo (14.5%), Paraná (14.3%), Rio Grande do Sul (10.8%), Goiás (8.8%), Minas Gerais (9.0%), Bahia (6.5%), Mato Grosso do Sul (4.7%), Santa Catarina (2.1%), according to IBGE (2006), Sindag (2011) and Theisen (2010).

## PESTICIDES

Agricultural pesticides can be subdivided into several categories according to the type of product. Insecticides are defined as synthetic, natural, or biological chemical substances that control insects. Control can result in the death of the insect or prevent behaviors considered destructive (MORAIS; MARINHO-PRADO, 2016). Fungicides combat fungi and exist in abundance (DANTAS, 2012). Herbicides fight weeds. In the last two decades, this group has been increasingly used in agriculture and one of the examples widely publicized by the specialized media is glyphosate, especially because it is currently the best-selling herbicide in Brazil. It is indicated for the control of annual and perennial weeds, monocotyledons or dicotyledons, in irrigated rice, sugarcane, coffee, citrus, apple, corn, pastures, soybeans (direct or indirect planting), tobacco, grapes and ratoon in sugar cane (AMARANTE JUNIOR et al., 2002). Rodenticides and rodenticides (dicumarins)

are used to combat rodents. Acaricides act to combat various mites. Nematicides are used to combat nematodes. Molluscids have anti-mollusc action, basically against the schistosomiasis snail. And fumigants have action to combat insects and bacteria: metal phosphides (Phosphine) and methyl bromide (MENDES, 2019).

According to this classification, pesticides are grouped according to the similarity of the molecular structures of the active ingredient that constitute them. The main classes of pesticides, according to their chemical structure, are: Organochlorines, which are synthetic organic pesticides that have the element chlorine in their molecules; Organophosphates are usually pentavalent esters derived from phosphoric and thiophosphoric acid and are the constituents of most current pesticides. (FARIA et al., 2004; LIMA et al., 2016); carbamates, which are part of a large group of synthetic pesticides, derived from carbamic acid esters (LIMA et al., 2016); and pyrethroids, which are insecticides of plant origin, obtained from pyrethrum, also known as Persian powder, extracted in the process of crushing the flowers of some plants belonging to the genus *Chrysanthemum*, family Compositae (SANTOS et al., 2007).

The use of one or more pesticides on crops for which they are not authorized, especially those in the reevaluation or scheduled discontinuation phase due to their high toxicity, has negative consequences on human and environmental health. One of them is the increase in food insecurity for consumers who eat food contaminated with active ingredients, as this use, being absolutely irregular, was not considered in the calculation of the acceptable daily intake (ADI), which is a numerical value, measured in mg/kg, which determines the amount that can be consumed of a substance that, even if ingested daily, will not cause harm to human health throughout

life. And this insecurity is worsened as this pesticide is found in several foods consumed in our daily diet. According to ANVISA (2011), these are active ingredients with a high degree of proven acute toxicity and that cause neurological, reproductive problems, hormonal dysregulation and even cancer (...) [and] Despite being banned in several places in the world, world, such as the European Union and the United States, there is pressure from the agricultural sector to keep these three products (endosulfan, methamidophos and acephate) in Brazil, even after they have been voluntarily withdrawn in other countries.

Thus, more and more cases of people directly contaminated by pesticides in rural areas are being reported. However, residents of nearby areas and, possibly, people in urban areas are also at risk, due to the contamination of foods such as meat, fish, dairy products, fruits and vegetables. The main people affected are farmers, ranchers, endemic disease control agents (ACE), workers at insect control companies and workers in pesticide industries, who directly suffer the effects of pesticides during handling and application (LONDRES, 2012).

Therefore, the risks to human health associated with the use of and exposure to pesticides have been the subject of great scientific interest in terms of global health. There are two types of classification of pesticide poisoning according to ANVISA (2012). (1) Acute Poisoning can occur mildly, moderately or severely, depending on the amount of poison absorbed, the absorption time, the toxicity of the product and the time elapsed between exposure and medical care. It manifests itself through a set of signs and symptoms, which appear suddenly, a few minutes or a few hours after excessive exposure of an individual or a group of people to a pesticide. Such exposure is generally unique and occurs within a period of up to 24 hours, causing rapid effects on

health. (2) Chronic Poisoning has several harmful effects on human health, such as mainly the accumulation of genetic damage, which arises during repeated exposure to the toxicant, which normally occurs over long periods of time. In these conditions, clinical conditions are undefined, confusing and often irreversible. Diagnoses are difficult to establish and there is greater difficulty in associating cause/effect, especially when there is exposure to multiple products. Chronic poisoning manifests itself through numerous pathologies, which affect various organs and systems, with emphasis on immunological, hematological, hepatic and neurological problems, congenital malformations and tumors.

The chronic effect occurs mainly because there are three main routes of pesticide absorption (dermal, digestive and respiratory), which increases the biological area of exposure to these chemical agents. Thus, due to the high toxicological capacity, the Health Care Protocol for Workers Exposed to Pesticides, prepared by the Ministry of Health (BRASIL, 2006), demonstrates some pathologies related to chronic poisoning by agricultural pesticides, such as: neoplasms, such as myeloma multiple and leukemias; aplastic anemia; mental disorders, such as cognitive changes and depressive episodes; nervous system diseases such as movement disorders, polyneuropathies and toxic encephalopathy; ocular, such as optic neuritis and vision disorders, as well as auditory, circulatory, respiratory, digestive and dermatological disorders.

Additionally, some pesticides remain stored in the tissues of plant and animal organisms, including humans, as is the case with pesticides that use organochlorines. Therefore, this situation becomes even more alarming due to the high lipophilicity of pesticides, which provides easy absorption



through the skin and distribution to tissues by transport of plasma linked to albumin and lipoproteins. After absorption, substances can diffuse between membranes, internalize into cells, and accumulate in organs with high levels of fat, including the liver, kidneys, brain, and breast tissue. In addition to bioaccumulation, the long persistence in the environment makes agricultural pesticides susceptible to biomagnification along with trophic levels. In lactating women, the distribution of blood and fatty tissues to milk promotes exposure of newborns to these toxicological substances, something extremely worrying, given that breast milk is the only food that provides important nutrients for brain development, which fights infections, protects the child against bacteria and viruses, and prevents diarrhea. As human milk is the main food consumed by babies in the first months of life, the presence of contaminants results in an increased risk to children's health, especially in the critical phase of development in which the biotransformation pathways of chemical agents are not fully developed, and the enzymes necessary to metabolize and eliminate these agents are absent or deficient (SOUZA et al., 2020).

As a result, health issues can include endocrine changes, impaired growth and development, especially the development of the nervous system, which can result in reduced intelligence quotient, and behavioral abnormalities. Furthermore, exposure to pesticides is linked to an increased risk of developing cancer, including leukemia, sarcoma, lymphoma, Wilm's renal tumor, and brain cancer, followed by impairment of the immune system that triggers the risk of infectious diseases. Most of these health effects can occur after chronic exposure to low doses, and it is not possible to establish maximum acceptable limits for human exposure to these contaminants, since several

of them produce irreversible effects and are not disease-dependent (SOUZA et al., 2020).

However, this knowledge allows us to visualize only the tip of the iceberg, since, from an epidemiological point of view, the assessment of the pathological potential of pesticides is extremely complex. The difficulties are numerous, given the heterogeneity of the compounds used, the diversity of application methods and the lack of adequate data on the nature of exposure. Furthermore, the level of exposure to pesticides estimated in epidemiological studies does not always represent its real intensity. As a precise quantitative approach is difficult to carry out, subjective measures end up being used, such as, for example, exposure time, geographic area or frequency of use. Even though some of the AIs (active ingredients) can – based on their acute effects – be classified as moderately or slightly toxic, one cannot lose sight of the chronic effects that can occur months, years or even decades after exposure, manifesting themselves as in various diseases such as cancer, congenital malformations, endocrine, neurological and mental disorders (CARNEIRO et al., 2012).

### **CYPERMETHRIN, PERMETHRIN AND GLYPHOSATE: EXAMPLES OF PESTICIDES AND HEALTH IMPACTS**

Cypermethrin, a pesticide classified as highly toxic (class II), whose mutagenic and genotoxic potential has been proven in different studies: chromosomal aberrations, induction of micronuclei, sperm alterations, dominant lethal mutations and sister chromatid exchanges were observed in mice (BHUNYA; PATI, 1988; SHUKLA; TANEJA, 2002; CHAUHAN; AGARWAL; SUNDARARAMAN, 1997, cited by CARNEIRO et al., 2012). In human lymphocytes treated with cypermethrin, chromosomal aberrations and sister chromatid

exchanges were also observed (KOCAMAN; TOPAKTAS, 2009).

Permethrin is associated with the appearance of multiple myeloma in humans (RUSIECKI et al., 2009) and is classified as a possible carcinogen by the Environment Protection Agency (EPA) in the United States. This substance, applied to rats, caused neurobehavioral deficits in the animals (ABDEL-RAHMAN et al., 2004, cited by CARNEIRO et al., 2012). Lambda-cyhalothrin is associated with the appearance of neuromotor disorders (WOLANSKY et al., 2006).

Glyphosate deserves to be highlighted because it is the most consumed herbicide in Brazil. Studies indicate that it is a disruptor of the human endocrine system (CURWIN et al., 20021; FARIA; ROSA; FACCHINI, 2002; SOLOMON; MARSHALL; CARRASQUILLA, 2003; VARONA et al., 2004, all cited by BELO et al., 2012), has genotoxic potential (GASNIER et al., 2005; POLETTA et al., 2006; MLADINIC et al., 20097, cited by BELO et al., 2012), allergic (HERAS-MENDEZA et al., 2008; PENAGOS et al., 2009; NIELSEN; NIELSEN; SORENSEN, 2010; SLAGER et al., 2011, all cited by BELO et al., 2012) and promoting liver problems (CHALUBINSKI; KOWALSKI, 2006; EJAZ et al., 2004, cited by BELO et al., 2012). Another in vitro study demonstrated that glyphosate, in its commercial forms and technical grade (active ingredient), was toxic to human peripheral blood mononuclear cells, with commercial forms being more cytotoxic than technical grade glyphosate, reinforcing that additives and other adjuvants increase the toxicity of the product (MARTÍNEZ; REYES; REYES, 2007, cited by PARANÁ HEALTH DEPARTMENT et al., 2013).

## CONCLUSION

The data analyzed demonstrate that pesticides represent a significant threat to human health. Numerous scientific studies have demonstrated a correlation between exposure to these substances and a range of adverse health problems. Pesticides are designed to eliminate pests, diseases and weeds that affect crops, however, their toxic effects are not restricted to the desired targets.

The chemical compounds present in pesticides can persist in the environment and accumulate in the food we consume daily. When we eat these contaminated foods, we are subject to the absorption of these toxic agents by our body, which can accumulate in various tissues, especially breast milk. This situation is alarming given that it is the main food for newborns and infants, providing essential nutrients for their healthy growth and development. However, the presence of pesticides in breast milk can result in the transmission of these substances to babies, exposing them to potential risks. The effects of pesticides transmitted through breastfeeding are extremely worrying, as newborns and infants are at a crucial stage of development, with immune systems and organs still being formed. The studies analyzed demonstrated that early exposure to pesticides may be associated with neurological development disorders, cognitive impairment, respiratory problems, endocrine disorders and an increased risk of developing chronic diseases throughout life.

It is important to highlight that each individual is exposed differently to pesticides, which makes studying the effects of pesticides on human health even more challenging. The diversity of environmental factors, such as population location, occupational factors, especially associated with exposure in agriculture, individual factors, such as age, number of pregnancies, medical conditions,

social factors, such as income and education level, and dietary factors, such as Consumption habits of contaminated foods and the process of bioaccumulation influence the quantity and way in which these substances are absorbed, metabolized and eliminated by the body. This complexity makes it difficult to carry out comprehensive and conclusive research on the specific effects of pesticides on different population groups.

However, given the growing concern about

food safety and public health, it is imperative that more studies and research be carried out in this field. It is necessary to deepen our understanding of the long-term effects of exposure to pesticides, as well as to investigate sustainable and less harmful alternatives for food production. This research can provide crucial information to inform more effective public policies, encourage safer agricultural practices, and protect the health of both present and future generations.

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